

# Mercury in Fish from 21 National Parks in the Western U.S. and Alaska

*Inter- and Intra-park variation*

Utah Statewide Mercury Workgroup:  
September 30, 2014

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Prepared in cooperation with the National Park Service, Air Resources Division

## Mercury in Fishes from 21 National Parks in the Western United States—Inter- and Intra-Park Variation in Concentrations and Ecological Risk



Eagles-Smith, C.A., Willacker, J.J., and Flanagan Pritz, C.M., 2014, Mercury in fishes from 21 national parks in the Western United States—Inter and intra-park variation in concentrations and ecological risk: U.S. Geological Survey Open-File Report 2014-1051, 54 p.

<http://dx.doi.org/10.3133/ofr20141051>.



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### National Park Service and USGS News Release

Release date: April 16, 2014

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#### Elevated Levels of Mercury Found in Fish in Western U.S. National Parks

*Concentrations safe for human consumption in 96 percent of sport fish sampled*

WASHINGTON. — Mercury has been discovered in fish in some of the most remote national park lakes and streams in the western United States and Alaska. Mercury levels in some fish exceeded U.S. Environmental Protection Agency health thresholds for potential impacts to fish, birds, and humans.

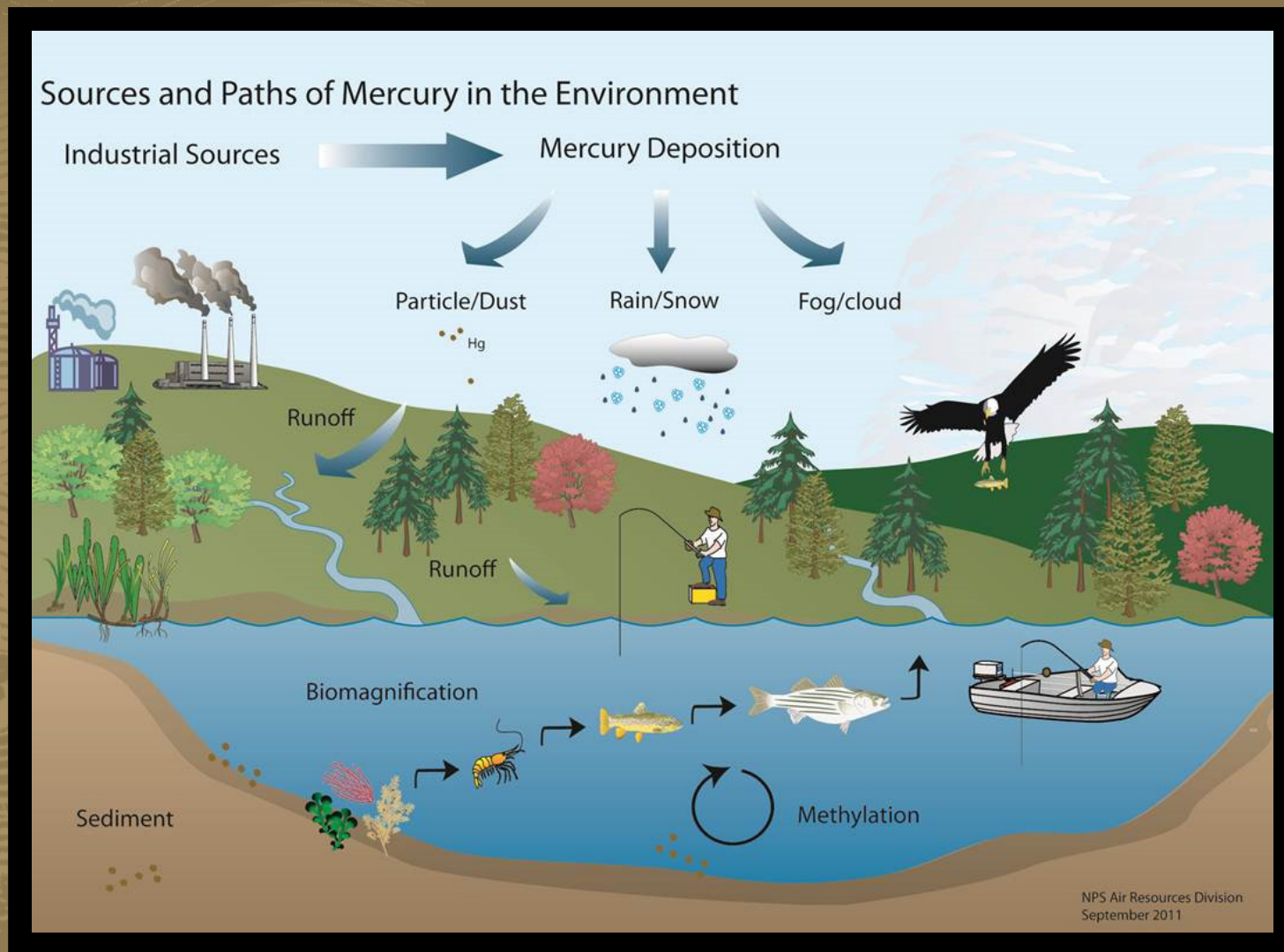
# National Park Service (NPS)



- Created in 1916
- 401 NPS units in 50 states, DC, and 4 territories
  - National Parks (59), Historical Parks/Sites (124), Monuments (108)
- Total acreage ~ size of Montana
- 2013: 274 million visitors
- Employees: 22K FTEs, 25K concessioners, 200K volunteers

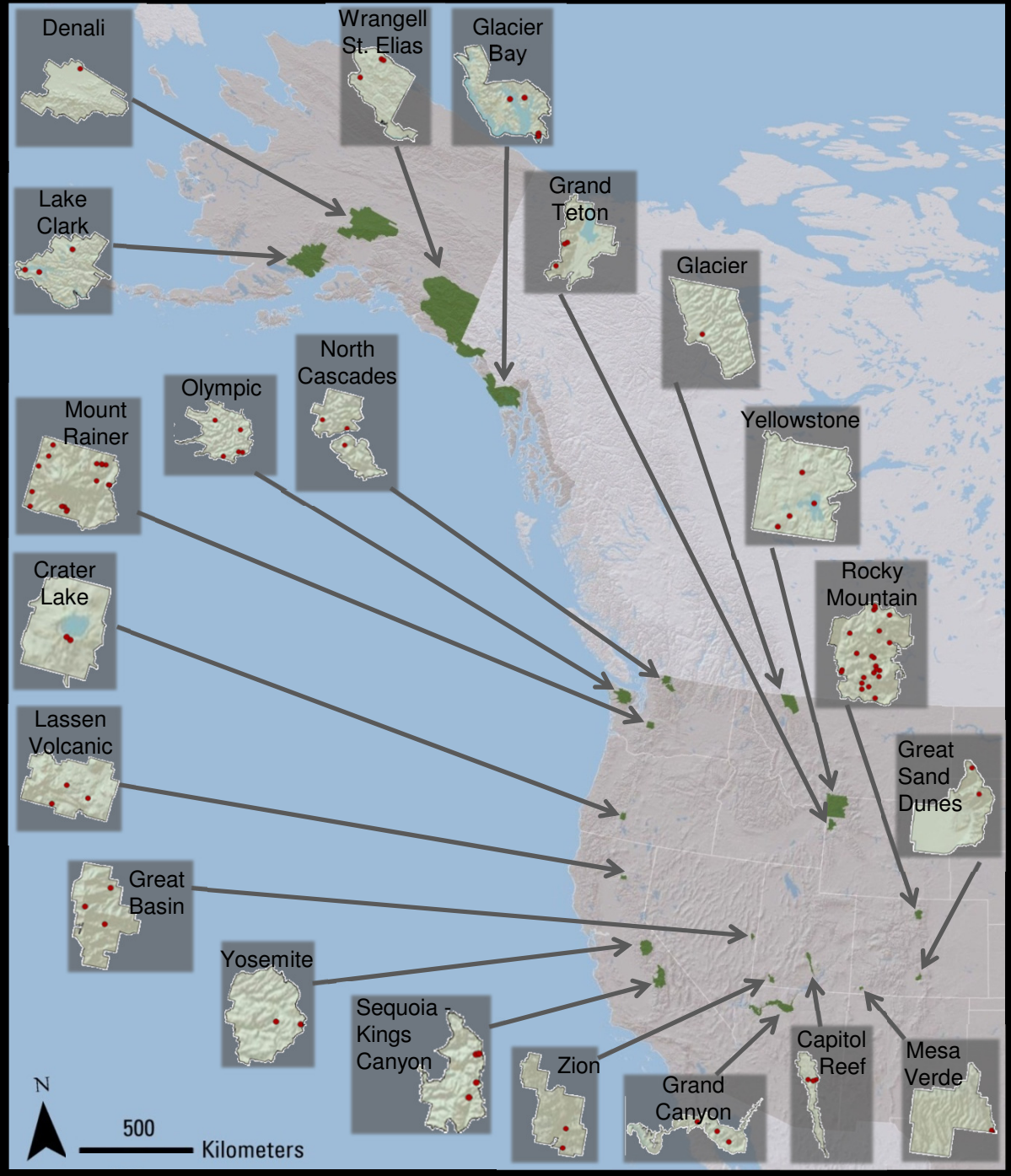


# Mercury (Hg)



# Study Area

- 21 parks
- 86 sites
- 10 states
- 4,000 km
- 1,486 fish





# Site Selection

- Remote aquatic habitats
- High-elevation (where possible)
- Limited watershed inputs (where possible)
- Only non-migratory fishes

Middle Blum Lake, NOCA



Crater Lake, CRLA



Lake Clark, LACL



Fremont River, CARE



# Target Species

Brook trout



Rainbow trout



Cutthroat trout



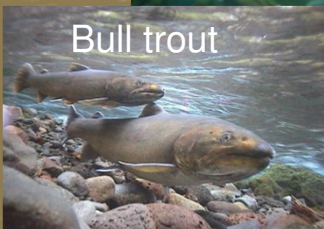
Lake trout



Northern pike



Bull trout



Arctic grayling



Golden trout



Brown trout



Kokanee



Dolly Varden



Torrent sculpin



Threespine stickleback



Speckled dace



Lake whitefish



Sucker spp



73%



# Hg Analysis

- Thermal decomposition
- Catalytic conversion
- Amalgamation
- Atomic absorption spectrometry
- EPA method 7473





# Statistical Analysis

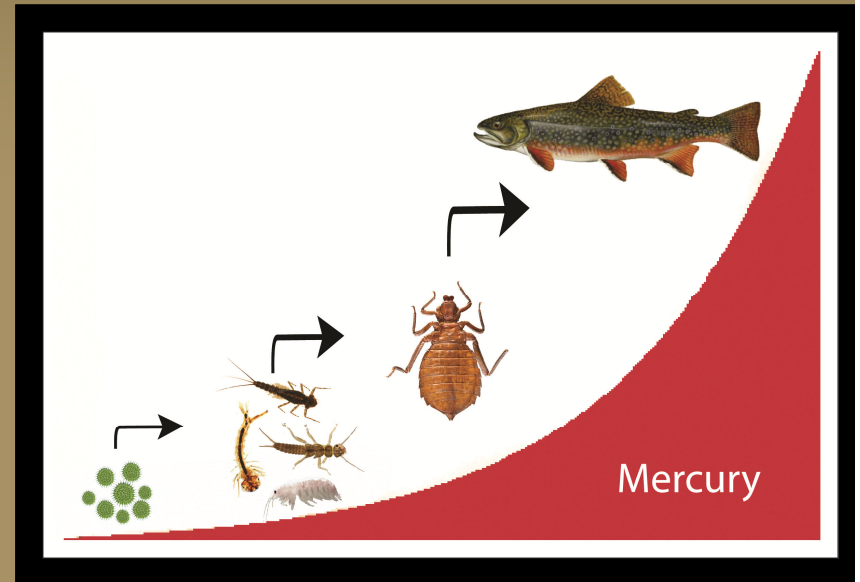
- Model selection to determine populations needing size correction
- Size-corrected Hg concentrations based upon species
  - “Large” fish – 400mm
  - “Medium” fish – 200mm
  - “Small” fish – 50mm
- Mixed-effects, nested general linear model ANOVA
  - Park (fixed effect)
  - Site nested within park (fixed effect)
  - Fish species (random effect)
- Independent models for each size classification
  - 400mm, 200mm, 50mm



North Fork Virgin River, ZION

# Toxicological Benchmarks

- Fish Risk
  - NOER (0.2 ppm)
  - LOER (0.3 ppm)
- Wildlife Risk
  - High sensitivity (0.09 ppm)
  - Moderate sensitivity (0.18 ppm)
  - Low sensitivity (0.27 ppm)
- Human Risk
  - Unlimited consumption (0.05 ppm)
  - EPA criterion (0.3 ppm)
  - No consumption (0.95 ppm)





# Capitol Reef NP

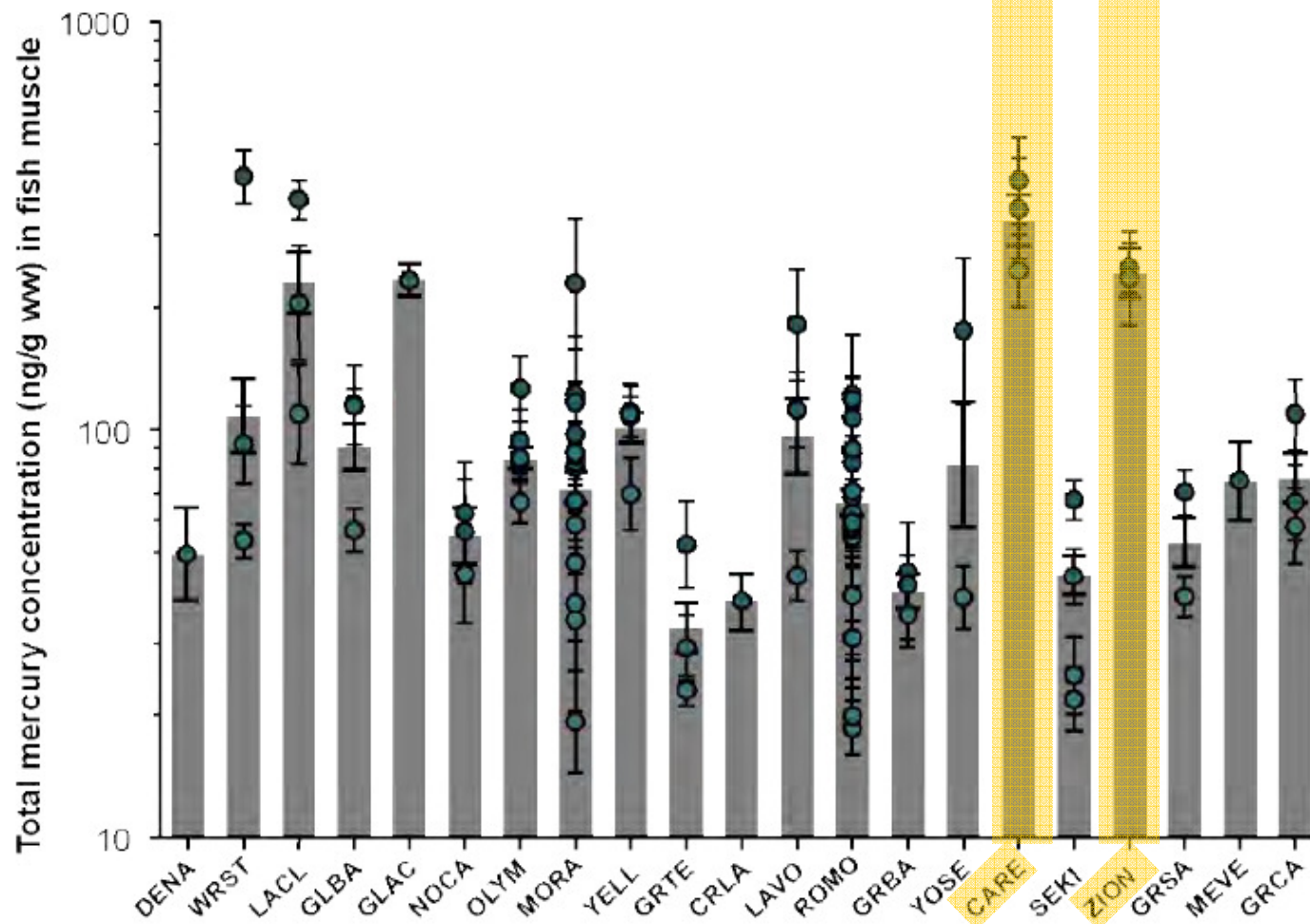
Fremont River		#1	#4	#7
Length (mm)	Median	54	60	65
THg (ww, ng/g)	Min	107.4	88.5	101.0
	Max	466.3	312.3	469.9
	Mean	266.6	162.3	237.2
	Median	287.4	142.4	217.3
% of samples exceeding fish risk thresholds	NOER	66.7	20.0	60.0
	LOER	33.3	6.7	26.7
% of samples exceeding avian risk thresholds	High-Sens.	100.0	93.3	100.0
	Moderate Sens	80.0	26.7	60.0
	Low Sens.	60.0	6.7	33.3
% of samples exceeding human risk thresholds	Unlim. Cons.	NA	NA	NA
	EPA Criteria	NA	NA	NA
	No Cons.	NA	NA	NA

# Zion NP

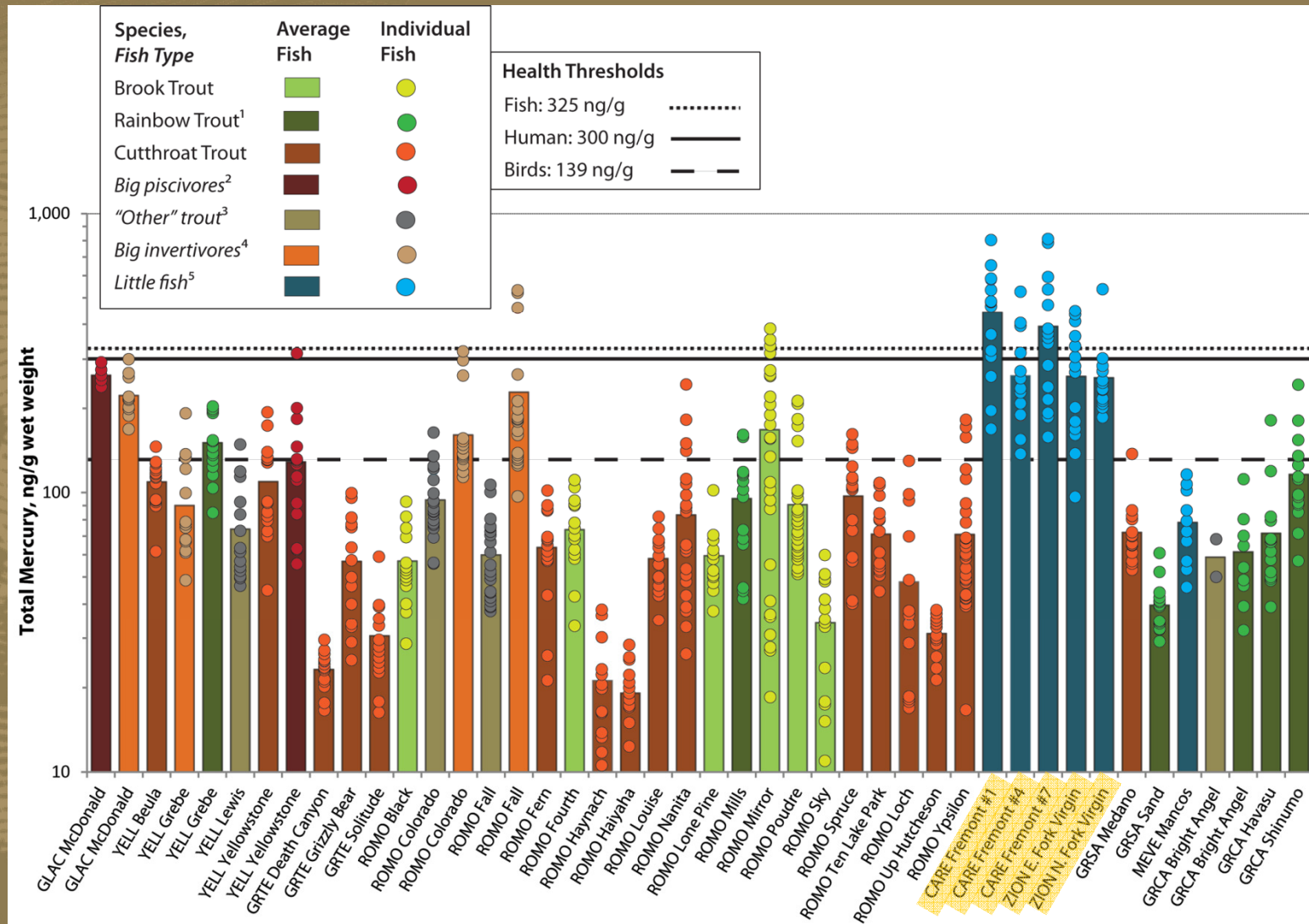
Virgin River		North Fork	East Fork
Length (mm)	Median	39	50
THg (ww, ng/g)	Min	117.5	63.4
	Max	185.4	268.7
	Mean	150.8	161.3
	Median	145.8	166.3
% of samples exceeding fish risk thresholds	NOER	0.0	33.3
	LOER	0.0	0.0
% of samples exceeding avian risk thresholds	High-Sens.	100.0	80.0
	Moderate Sens	6.7	40.0
	Low Sens.	0.0	0.0
% of samples exceeding human risk thresholds	Unlim. Cons.	NA	NA
	EPA Criteria	NA	NA
	No Cons.	NA	NA



# THg across 21 parks

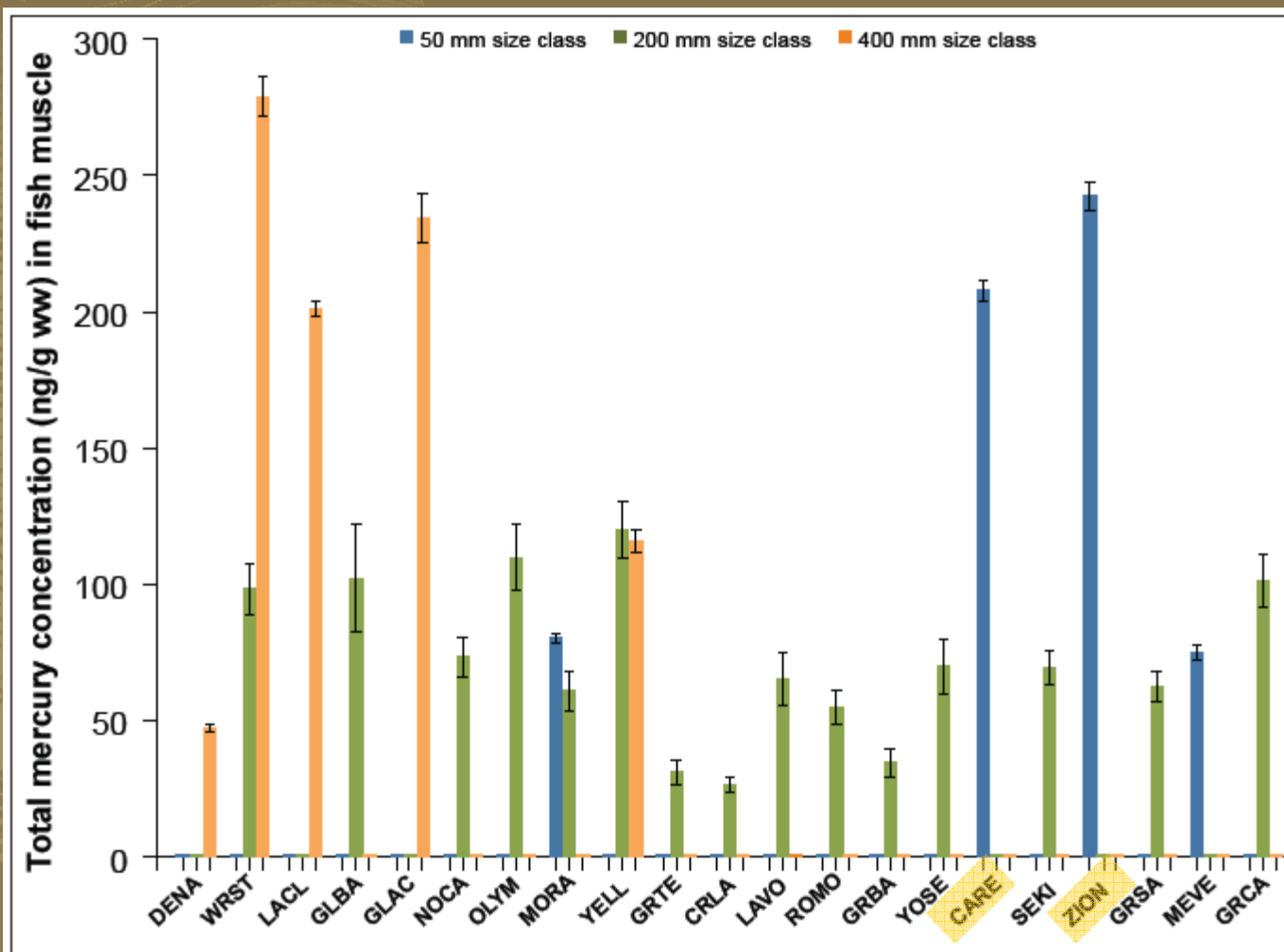


# THg in Intermountain West, by site



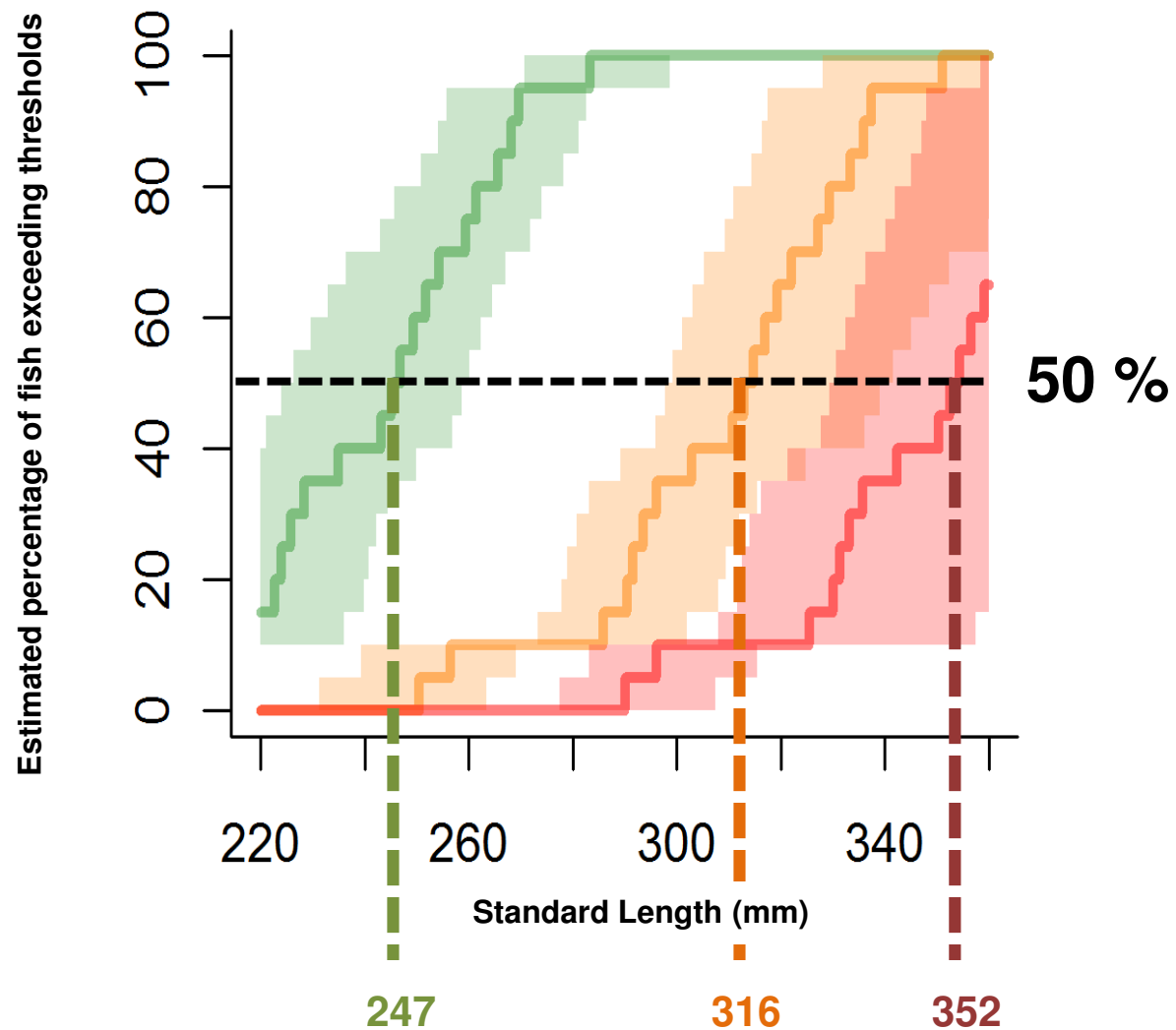


# Size-normalized THg in fish



EXPERIENCE YOUR AMERICA

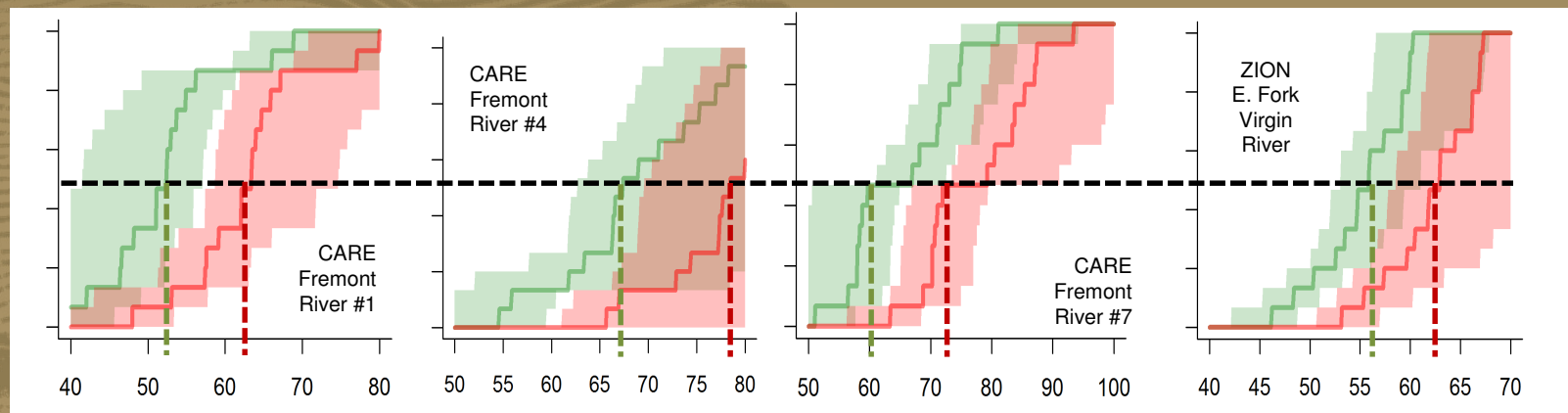
# Size-Specific Risk Profiles



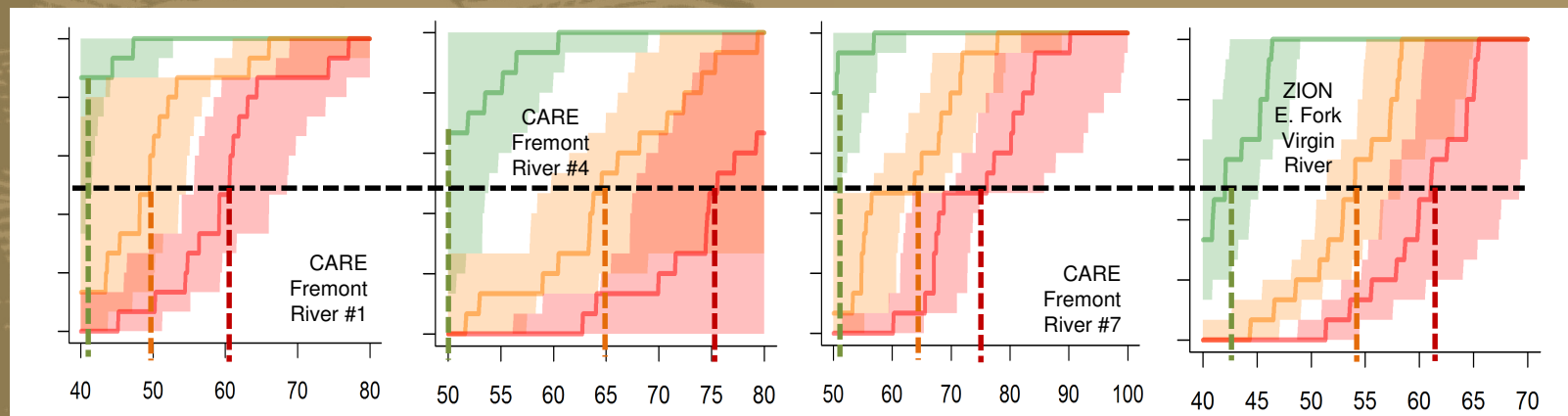


# Size-Specific Risk Profiles

- Size-specific risk to fish



- Size-specific risk to birds



# Findings

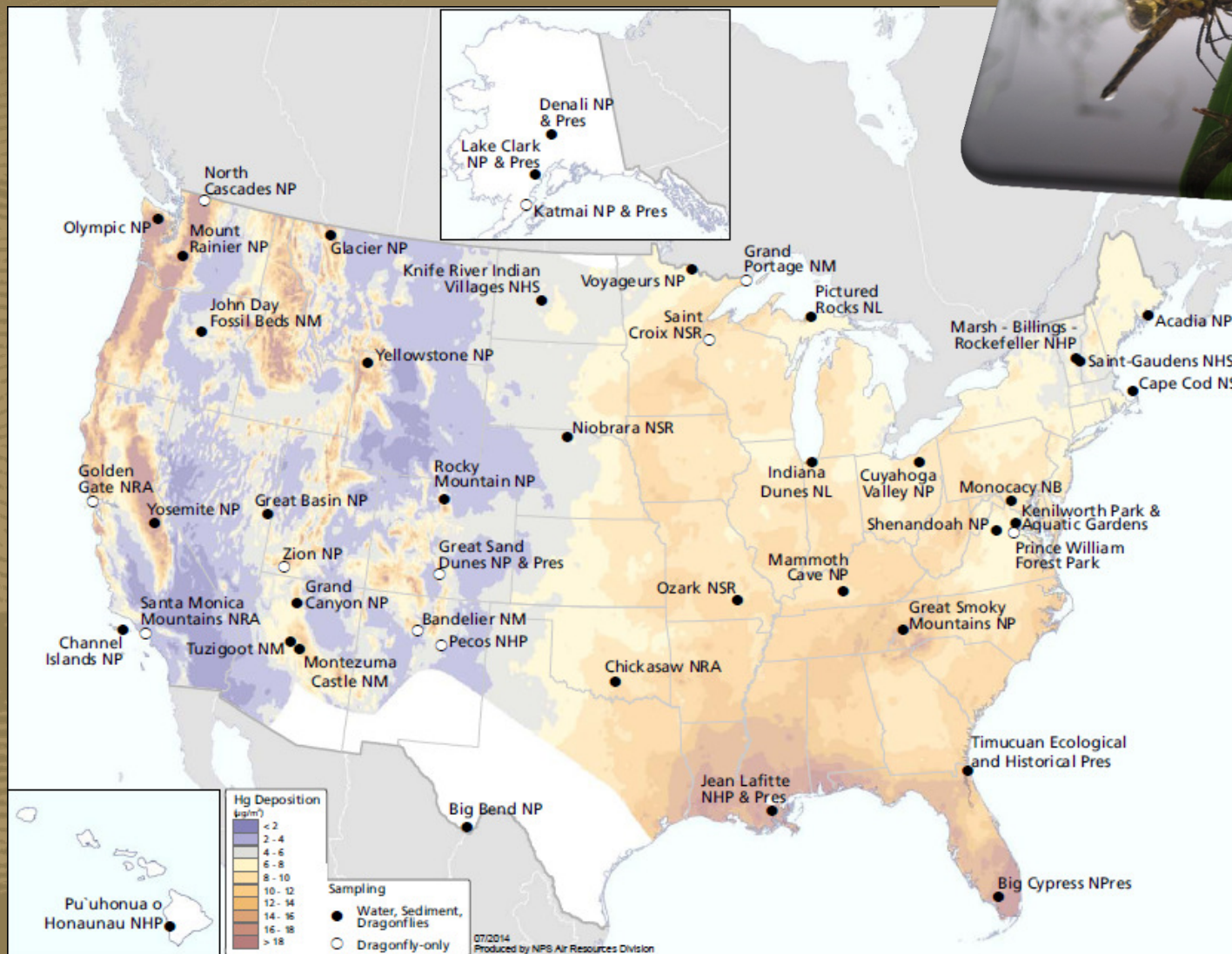
- Hg concentrations in fish sampled from these parks were generally low, but were elevated in some instances.
  - CARE/ZION: All fish sampled were speckled dace. These fish contained some of the highest Hg concentrations measured in this study, exceeding those measured in many of the largest predatory fish.
- The majority of fish across the West had concentrations that were below most wildlife and human health benchmarks
  - CARE/ZION: Hg concentrations detected at levels associated with biochemical and reproductive effects in fish, as well as reproductive impairment in birds
- Hg levels varied greatly, from park to park and site to site
- Hg concentrations were below EPA's fish tissue criterion for safe human consumption in 96% of the sport fish sampled
  - CARE/ZION: speckled dace=forage fish. No human consumption.
- The data suggest further study of key ecological endpoints in CARE, GLAC, LACL, LAVO, WRST, YOSE, ZION are warranted due to high levels of mercury in fish from these areas



# Next Steps

- “Why” was beyond the scope of this study...
  - Further integration with habitat and deposition layers to develop predictive models of Hg concentrations within sites is needed.
  - Integrate with USGS “methylation mapper”
  - Incorporation into Western Hg Synthesis
- Identify source contribution using mercury isotopes
  - Natural vs. Anthropogenic, Global vs. Domestic
- Further spatial assessments of risk using dragonfly larvae
  - National-scale study of Hg bioindicators led by UMaine and USGS FRESC
  - Citizen science-driven research that will further expand our understanding of Hg in the NPS
- Toxicological response research in parks and sites with indications of elevated risk (WRST, ZION, CARE, and others)
  - Examine factors regulating Hg accumulation in the lower trophic levels of these systems
- What happens at lower elevation sites with increased watershed inputs and methylation potential?

# Dragonfly Mercury Study





# Methylation Mapper

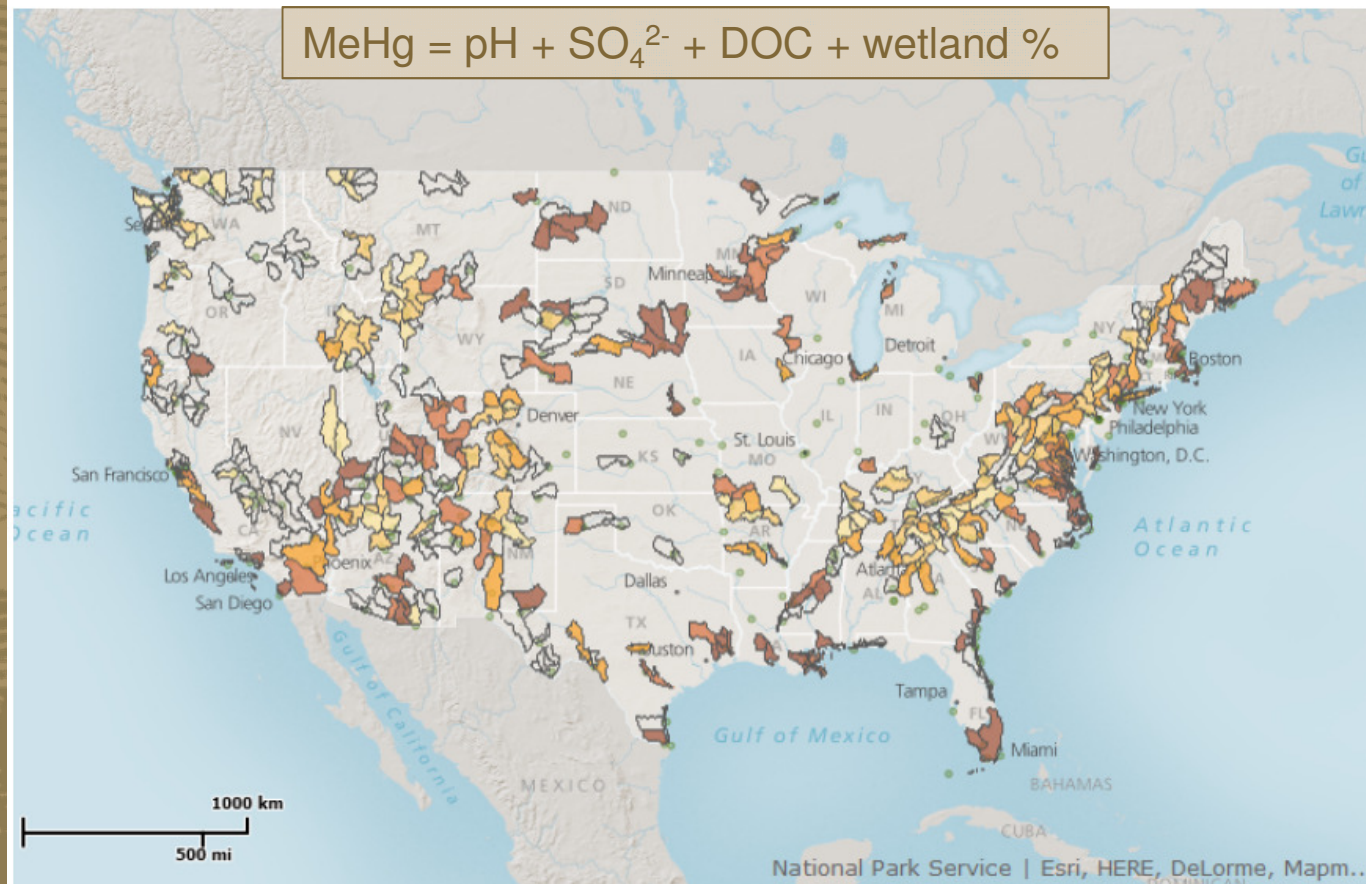


Estimated Methylmercury in  
National Parks

BETA VERSION



$$\text{MeHg} = \text{pH} + \text{SO}_4^{2-} + \text{DOC} + \text{wetland \%}$$



# Western Hg Synthesis



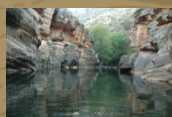
Hg deposition



Climate



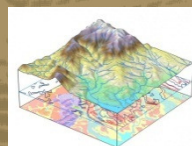
Hydrology



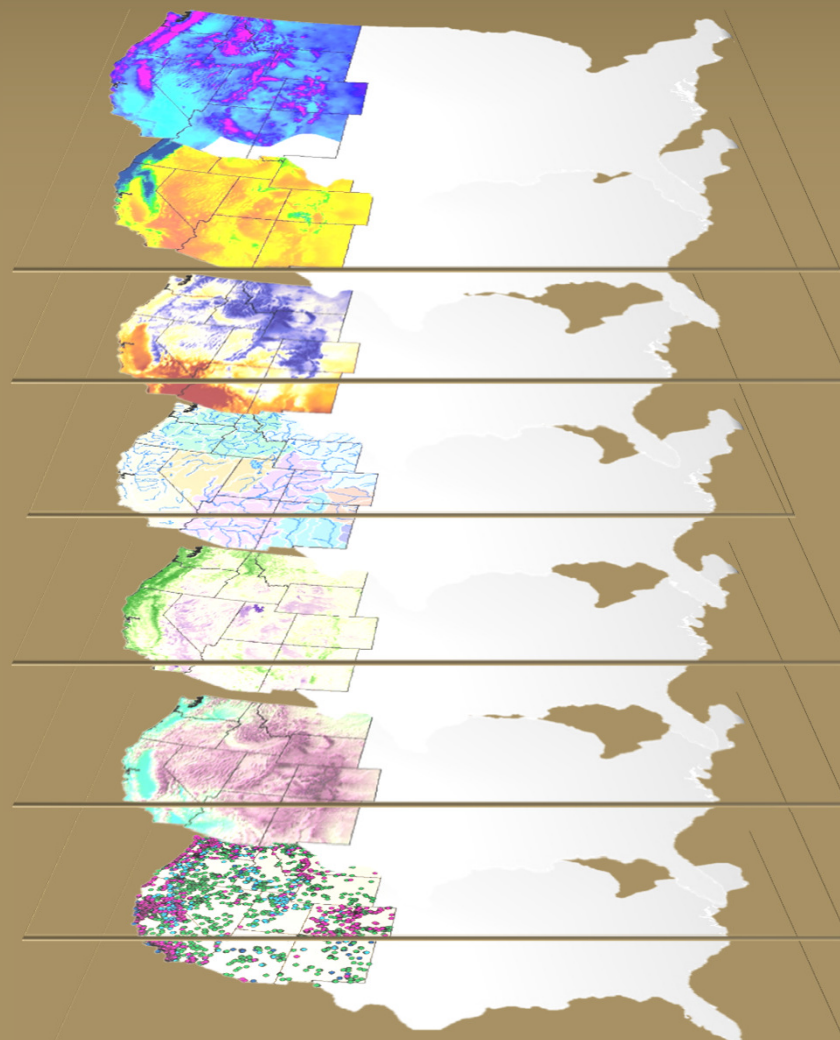
Land use change



Landscape structure



Multi-media Hg measurements





# National Park Service

Air Resources Division



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